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GUIDELINES FOR GROUNDWATER INVESTIGATION REPORTS

GENERAL INFORMATION

These guidelines suggest a format for reports. They do not include complete listings of techniques or topics, nor should all techniques described be used or all topics listed be dealt with in every project.

These guidelines are informational and are not regulations. Language used has been carefully gleaned of mandatory requirements. The guidelines have no force of law and do not set standards of practice. To be enforceable, the guidelines would have to be adopted as regulations in accordance with the Administrative Procedures Act.

On January 23, 1986, the Board of Registration for Geologists and Geophysicists (Board) passed the following resolution:

"The Guidelines have been adopted as useful information documents. Not having been adopted as regulations in accordance with the Administrative Procedures Act, the Guidelines are not legally enforceable."

These guidelines have their roots in eight California Division of Mines and Geology notes, that were published in California Geology during 1973-75. The four guidelines that evolved through the Technical Advisory Committee for the Board from 1983 to 1989 are:

Guidelines for Engineering Geologic Reports.
Geologic Guidelines for Earthquake and/or Fault Hazard Reports.
Guidelines for Geophysical Reports.
Guidelines for Groundwater Investigation Reports.

I. INTRODUCTION

These guidelines are prepared by the Technical Advisory Committee of the Board and adopted by the Board on April 18, 1998 to assist those involved in preparing and reviewing groundwater reports. The guidelines present the general procedures for reporting on groundwater investigations; and while they do not constitute a complete listing of all techniques for such studies, they do attempt to include all major topics.

Individual reports may include the topics discussed in this outline as appropriate. Purposes of investigations vary and may require that portions of these guidelines be either omitted or addressed briefly. Availability of funds is a limiting factor in a great many investigations. Site or areal conditions may necessitate variations in application of the guidelines. The professional performing, supervising or reviewing each investigation has a responsibility to determine what is appropriate and necessary in each case.

All geological, geophysical and related engineering work which falls within the scope of the Geologist and Geophysicist Act (Business and Professions Code, Chapter 12.5) and within the context of protecting the public's health and safety, must be supervised by adequately qualified, appropriately registered and certified professionals. It is important that the report clearly describes the work performed, unambiguously presents the results and be signed by the responsible professional(s).

Reports that present conclusions or recommendations based in part on field sampling, field testing or laboratory testing of samples need to include adequate descriptions of methods employed with specific reference to standard sampling and testing methods where appropriate. Generally, physical testing of earth materials and analysis of the data derived is performed by or under the direct supervision of a soils engineer. Chemical testing is performed by a laboratory certified by the California Department of Health Services.

II. REGULATORY AND LEGAL CONSIDERATIONS

Federal, state and local governmental agencies are involved in groundwater projects as planners, owner/operators and regulators. An intricate network of laws, both statutory and regulatory, governs such diverse considerations as rights to surface and groundwater; design and construction of waste disposal sites; water well and monitoring well design, construction and abandonment; disposal of mining and animal (feedlot) wastes; and sewage disposal. Any groundwater quality or quantity problem involves an inherent risk of future litigation because of possible adverse impacts to adjacent or regional properties (water level changes, water quality changes, contaminant plume migration, etc.).

Groundwater contamination studies include investigations of hazardous and nonhazardous waste disposal facilities (for both liquid and solid waste) and remedial investigations of chemical spills and leaking underground tanks and pipelines. Professionals engaged in such studies are expected to be cognizant of the hydrogeological and chemical environment, the requirements for chain-of-custody documentation, vadose zone and groundwater monitoring procedures, health and safety requirements and other applicable laws and regulations.

Dewatering for construction may require groundwater extraction methods such as wellpoint systems, freezing and electro-osmosis. Projects like these carry a high risk of later litigation because of unrecognized potential adverse effects to nearby users and property damage due to hydrocompaction.

III. REPORT CONTENT

The content of a report is influenced by a variety of factors including the purpose of the work and of the report, client requirements, standards set forth in regulations or law, internal standards of the organization preparing the report and confidentiality requirements.

A. Introduction

The introduction presents a clear and complete statement of the purpose of the report and the work, including limitations regarding the scope, level of study and methods used. The introduction may include the location of the project and introduce a location map showing where the site is in relation to landmarks, topographic features, etc. The time frame of the work and statements regarding authorization and confidentiality requirements also may be included. The introduction may include a summary of the investigators' findings, conclusions and, possibly, recommendations.

B. **Methods**

1. Data Base

   In groundwater studies, the existing data base is of primary importance because original investigations may not be part of the scope. The data base may include published and unpublished reports, maps, aerial photographs, well logs, historic water levels/water quality and interviews with agency representatives and members of the public. Each reference source should be clearly identified, and the factual bases be presented for different interpretations of conditions that each source describes.

2. Exploration Methods

   All new investigations--well canvasses, geochemical studies, borings, sampling, test wells and geophysical survey--and methods of performing the investigations should be described and their limitations included. Physical and chemical soil and water tests should be documented and referenced.

3. Data Analysis

   Methods of reducing and interpreting data from borings, test wells, geophysical surveys and physical and chemical soil and water tests should be explained and appropriate illustrations and references provided.

4. Modeling

   The type of model, its purpose and limitations, data used, justification for data not used and parameters modeled should be presented. The computer system, its capacity and software used with references should be noted. Most data should be displayed on tables or illustrations.

C. **Description of Hydrogeologic System**

A description of the hydrogeologic system typically includes the following information:

1. Regional Structure

2. Regional Stratigraphy

3. Water-Bearing Units

Thickness; depth; extent; characteristics such as lithology, permeability (transmissivity), storage, specific yield, gradient and confinement; and significance within the hydrogeologic environment.

4. Non-Water-Bearing Units

Thickness; depth; extent; characteristics such as permeability and restricting qualities.

Hydrogeologic data can be illustrated in many ways including cross sections and contour maps correlating data such as water levels and gradients.

5. Hydrologic Balance (for basin studies or for specific groundwater units)

a. System Inflow - Precipitation, surface inflow, subsurface inflow, percolation, imports, wastewaters.

b. System Outflow - Surface runoff, subsurface outflow, consumptive use (direct, evaporation, evapotranspiration), exports, wastewaters.

Hydrologic balance, in part, pertains to long-term availability of water to the groundwater system (recharge). The nature of precipitation, its amount, seasonal variation, intensity; the percolation characteristics of near-surface soils and loss of storage space due to hydrocompaction and stream courses are assessed in evaluating recharge.

D. Groundwater Use and Development

The amount and nature of groundwater use is typically compared to the storage, recharge and distribution of use among domestic, municipal, industrial and agricultural uses. Trends relating to demand and change of use should be discussed.

For springs, data on flow and characteristics should be tabulated. For wells, their number, depth, size, pumpage, drilling and construction methods, date of drilling, and availability of pump tests, lithologic logs and geophysical data should be covered. Well information is typically displayed in tabular form.

It is recommended that location maps of wells and springs be prepared. Well logs may be confidential, and their publication may require approval by public agencies and/or well owners.

Many groundwater supply projects require a discussion of the relationships between groundwater, surface water and conjunctive use. Groundwater use can cause a variety of undesirable results. Most of these results relate to users' health and safety. Intensive use can negatively affect groundwater availability or can cause ground subsidence, water quality changes due to sea water intrusion or inducing of poor quality or contaminated water into the groundwater system, loss of vegetation and other problems. Artificial recharge can cause rising groundwater levels with harmful or beneficial effects.

Groundwater use could be beneficial to some land uses by lowering high groundwater levels. The report should consider the various effects of groundwater use and development.

E. Water Quality

The standards of water quality vary widely for domestic, agricultural and industrial uses. Health issues involving water quality are of particular importance when standards of professional practice are considered.

1. Biological Quality

   Biological quality, such as coliform content, etc., is of particular concern as a health consideration for drinking water.

2. Mineral Quality

   Common ions, general groundwater type, pH, temperature, total dissolved solids and hardness, and certain minerals (such as boron, fluoride, nitrate and nuisance and toxic metals) are generally noted in a discussion of the mineral quality of water.

   Water quality data may be displayed in various forms using tables, special diagrams and contour maps of equal concentrations.

3. Groundwater Contaminants

   Investigation of groundwater contamination depends on detailed knowledge of the hydrogeology of the site and the physical and chemical behavior of the contaminants. A study may involve the definition of contaminant plumes, their mobility and relative importance, particularly with regard to existing water supplies. Physical and chemical behavior of the contaminants, such as solubility and density, are generally considered in the design of an appropriate monitoring program.

   The hydrogeologic framework should identify possible contaminant migration paths, rates of contaminant transport and the possibility of communication between aquifers. The fate of contaminants in the hydrogeologic system is typically addressed. Such parameters as attenuation, dispersion, transformation and effects on physical conditions (e.g., permeability) should be fully discussed. Groundwater sampling and analytical protocols need to be specifically tailored for the types of contaminants involved.

   Groundwater contamination studies may require the evaluation of remedial action and cleanup options. Such options might include plume monitoring, extraction with surface treatment, physical or hydraulic containment, injection well(s) or biological control. Cleanup programs often involve combinations of the above.

F. Groundwater Management

Recommended methods and techniques of groundwater management may be presented as a result of the investigation as follows:

- Controlled pumping to eliminate or reduce overdraft or protect water quality;

- Conjunctive use of surface water and groundwater;

- Artificial recharge; and

- Water quality control measures.

G. Conclusions and Recommendations

This section of the groundwater report typically includes interpretive statements based on data obtained and professional judgment and addresses the specific action that may be required. Recommendations should be clearly and concisely stated and emphasize practical solutions whenever possible.

SELECTED REFERENCES

The following texts contain very extensive reference lists on various aspects of groundwater and are excellent references:

Bower, Herman, 1978, Groundwater Hydrology, McGraw-Hill.

Fletcher, Driscoll G., 1986, Groundwater and Wells, 2nd Ed.

Freeze, R. Allan and Cherry, John A., 1979, Groundwater, Prentice-Hall.

Roscoe Moss Co., 1990, Handbook of Ground Water Development.

Todd, David K., 1980, Groundwater Hydrology, second edition, John Wiley.

Results of current research on various aspects of groundwater appear in various publications. Of particular note, are the following:

Environmental & Engineering Geoscience, a joint publication of the Association of Engineering Geologists and the Geological Society of America.

Ground Water, published by the National Ground Water Publishing Co.

Ground Water Monitoring & Remediation, published by National Ground Water Publishing Co.

Water Resources Research, published by American Geophysical Union.

Publications of various governmental agencies are essential references, especially from the following agencies:

California Department of Water Resources

California Division of Mines and Geology

California Water Resources Control Board

U. S. Environmental Protection Agency

U. S. Geological Survey

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